

Influence of pre-treatment on the ratio of oil to total liquid fraction from vacuum pyrolysis of various biomass

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Introduction

Pyrolysis is now recognised as one of the potential routes for liquid fuel generation from biomass. There are different processes developed, and can be broadly classified as fast pyrolysis and vacuum pyrolysis. Fast pyrolysis have developed to an advanced stage to give upto even 80% liquids, whereas vacuum pyrolysis has had the advantage of inherent reduction in the entrainment of fines and char particles in the volatiles. However, the combustible fraction in both are yet to be solved for their stability and time dependent polymerization problems along with others like corrosivity, etc. This paper is a report of one of the studies towards systematic research in understanding the above mentioned problems.

Work description

The present paper reports the studies made on pyrolysis product distribution, particularly the liquid fraction. The percentage of oil or combustible portion in the total liquid (i.e. the total condensable portion of the volatiles released upon pyrolysis) is studied and compared for different biomass and for different pre-treatment conditions. The effect of de-ashing on the 'total volatiles' produced is discussed in detail by Raveendran et.al [1] and correlations are also developed for determining the liquid fraction as a function of the biomass components and ash constituents. The term 'total volatiles' includes the water-soluble non-combustible portion as well as the other oil fraction, which is combustible. This paper studies the ratio of oil to 'total liquid' for different biomass. The comparison between different biomass (under same pre-treatments) as well as different treatment on one biomass is studied. (It may be noted that a part of the study on sugarcane bagasse on different pretreatment methods for oil production has been dealt with in another paper [2])

The present work has been carried out in a vacuum-pyrolysis packed bed and four different but common biomass have been studied. They are:

1. Ground-nut shell
2. Wood
3. Rice-husk
4. Bagasse

Each of them have been studied under three conditions:

1. Untreated (dried)
2. After leaching (dried) and
3. Leached with 5M HCL solution (dried)

Results and discussion

All the above mentioned biomass were treated for the three pretreatments. They were then pyrolysed under vacuum and different fractions condensing at different temperatures were collected. The first few fractions contained the combustible portion. The first fraction was most viscous. However upon mixing all the combustible fractions, the resultant was found to be less viscous.

The total liquid fraction i.e. all the condensates together was measured. The total liquid/condensable fraction was the highest for bagasse (55%), and the lowest for Groundnut shell (40%), and the respective oil fraction being 19.5% and 11 % respectively.

Upon leaching, the oil yield increased by almost 200% for bagasse, and in the range of 25-35% for the others. The total liquid fraction on the other hand increased only by 17% for bagasse and in the range of 2-6% for the others. Taking into account the weight loss due to pretreatment, there is a reduction in the total liquid production by about 17% for bagasse, whereas the reduction in this fraction for other biomass on leaching is negligible. The oil fraction however increases for all four biomass, the highest being about 62% for bagasse.

The results are of similar trend for biomass pre-treated with 5M HCL solution, with the increase in oil yield being more than on leaching with water.

However, it is interesting to note that the calorific value of the oils though decrease slightly in absolute values, are negligible in terms percentage decrease.

The results therefore indicate the role of pre-treatment in removal of selected ash components as well as a part of holocellulose, which in turn change the characteristics of the volatiles that are released. Attempts have been made in developing mathematical correlations to predict the oil quantity under the studied pyrolysis conditions. The simultaneous effect on the adsorbent characteristics of the residual char is an additional facet of study reported in the paper.

Conclusion

The pre-treatment of biomass influences not only the total liquid fraction in the volatiles, but also the fraction of combustible oils in the liquids. The energy distribution amongst them is also altered. The study can be used effectively to increase the oils yields as well as the adsorptivity of the chars thereby produced. It may be very clearly concluded that sugarcane bagasse as a biomass behaves differently than the other three biomass studied.

References

- [1] K Raveendran, Anuradda Ganesh and Kartic C Khilar, "Influence of Mineral Matter on Biomass Pyrolysis Characteristics", In: Fuel, vol. 74, n-12, 1995, pp. 1812 – 1821.
- [2] Piyali Das and Anuradda Ganesh "Influence of Pre-treatment of Biomass on Pyrolysis Products", paper already submitted for the same conference.